Chapter

Kinematical Analysis of the Volleyball Auction in Preyouth and Youth Players of the Pichincha Sports Concentration

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Abstract

The finish is an essential element since it is a major action within offensive elements that help the team get points, so it is necessary to analyze each of the phases of this foundation. As such need is to analyze the different angles of movement, speed and center of mass to establish kinematic reference values of the gain shape values that can serve as a reference when the technique of the players so potentiate the driving habit means is analyzed optimizing sports training at all levels. The authors of this study aimed to biomechanically analyze the phases of the auction volleyball in prejuvenile and young players of Pichincha sports concentration. They studied 19 volleyball players from the Pichincha sports concentration under non-probability purposive sampling, with 11 athletes from the prejuvenile team and 8 youth team athletes. Kinovea to measure software (experimental version) was used and the U test was used Mann-Whitney SPSS d e13 digital camera megapixels, measuring tape and HP computer with Intel Core i5 processor. In the approach phase, there was no significant difference in regard to the column angle ($p = 0.457$). In whipped phase, no significant difference in column angle ($p = 0.283$). In the preparation phase for beating on the angle of the elbow, there is no significant difference ($p = 0.83$). In the striking phase at the angle of the elbow if there is significant difference ($p = 0.002$). In the decay phase in the column angle no significant difference ($p = 0.83$). This was established with the Mann-Whitney U test. Column angles do not significantly influence the auction technique. However, the influence of angles of the elbow was observed, for better elbow flexion and hand placement can generate a greater impact on the ball and therefore greater difficulty in opposing defense.

Keywords: biomechanics, auction, movement angles, center of gravity, volleyball

1. Introduction

The remante is a technical gesture of great importance in volleyball and is also the most important offensive element (attack) consisting of two previous actions before sending the ball: these are terminal and continuity within terminals we serve, block and remante [1]. This technique is one of the most decisive factors in

athletic performance. In volleyball, it can produce more than 100 shots during a game by one player; so, the difficulty lies in combining skills with previous career jump and hit. Therefore, the auction should have a refined technique that allows executing proper moves to achieve economy and rationality of the effort [2]. One of the factors that stand out performance in volleyball is the force as it contributes to the physical appearance and efficiency of the game [3]. The effectiveness of the auction to determine success of the attack and the possibility of achieving several points suggests authors that 60% of the points are obtained through the auction where the core has a 78.8% efficiency pins 83.3%, opposite 75.7% and finally the offensive 62.9% effective in total offensive actions [4]. Within a party hop count it is 1802 of this amount 35% are breaks the remante [5].

The effectiveness of the technique in biomechanical terms is given to achieve the greatest possible height of the center of gravity in the boost phase, and hit the ball at the highest point maximum printing speed and accuracy at the time of the beating [6].

The auction requires explosive strength, speed, and accuracy [7]. This technical element involves special features because it is done without a base of support such that parts of the lower body are completely suspended in the air to hit the ball; therefore, the center of gravity tends to change and it should be emphasized that 100% of the time it takes the shot exists opposition adversary (lock) [8] therefore jump over the network and project the ball as much force does not guarantee you get points because factors such as skill, coordination and precision hand oculus also complement the movement. From the point of view of biomechanical studies, analysis of the auction aims to provide relevant information about the kinematic and kinetic results of the implementation of the technical element (auction) and thus to establish movement patterns whose aspects are expressed to be corrected during the learning stages of the auction and the correlation they have with the ideal models, that is more experienced players to correct finally identifies movements that can be the cause of injury during sports [9].

Moreover, the auction consists of two parts: the jump and hit, where the jump aims to achieve the maximum height of the center of gravity because it allows exceed block the opponent and finally the goal of beating is to get as much strength, speed, and accuracy in order to reduce the response time of the opponent [10]. In the phase of the jump one can see that the body tends to bend forward at the waist [11]. Applying biomechanical laws to this movement, we can say that he achievement not hit the ball with maximum force because the existence hip flexion biokinetic chain does not activate all levers, and according to Newton's second law the acceleration acquired by a body is proportional to the force applied to it; that is, in the auction the player, he must stay with his motionless body during impact [11].

The auction is divided into five phases: 1st approach stroke, Whipped 2nd, 3rd Preparation of beating, 4th and 5th Fall beating. The first two phases aim to achieve the maximum height of the center of gravity through the jump in the following two phases, which seek to achieve the right ball speed, strength, and direction; finally, the last phase seeks to cushion the body segments after the jump [10] (**Figure 1**).

During the advance stroke the player reaches between 50 and 60% of its maximum speed [13] since its goal is to produce the greatest amount of movement to the beating or biomechanical terms generate the horizontal movement needed to transform it into vertical movement (jump) plus a career boost generates effective 20% more height on the jump, this is the performs diagonally to the grid because in zone IV oblique race 45 is described to 60° while in zone II the path is straight with an angle of 60–90° because the player must finish off the network [8]. Travel speed and the number of steps required to reach the ball will depend on anthropometric

factors of the player such as the stride length and angles of movement. At this stage, the final step becomes the most important and, therefore, should be broader and faster, allowing slow down of the other foot to generate a parallel supporting foot (heel, sole, and toe), culminating in the knee flexion; the time taken for this is approximately 0.17–0.19 and most commonly used muscles in motion are: quadriceps, buttocks, adductor, biceps femoris, twins, hamstrings, and erectors of the spine (**Figure 2**).

Phase whipped aims leave the player with the shoulder of the arm that performs the beating ahead of the ball; it lasts for an approximate time of 0.13–0.18 and the most commonly used muscles are: trapezius, deltoids, biceps, pectoral in the upper body and quadriceps, glutes, adductors, hamstring, calves, hamstrings and erector spine in the lower body [8]. It must be taken into consideration that during this phase, the body weight is transferred to the heels, then to the soles of the feet, and ends at the tips that accompany rapid and strong arm movements, ending in the explosive spread of the train generating lower takeoff [14]. During beaten two periods where there support and a subsequent double support because these let you apply as much force to raise the center of gravity, require the coordination of arms to produce more vertical speed and increase power occurs the jump which will allow to have a height greater flight and elevation to the time of the beating [1]. This technical element depends on the skill of the player as well as physical aspects such as the explosive force of the lower body, neuromuscular coordination, and genetic traits like height; however, the generate an optimum amount of vertical speed (feed stroke) height is maximum.

Figure 1.
Phases sequence shot [12].

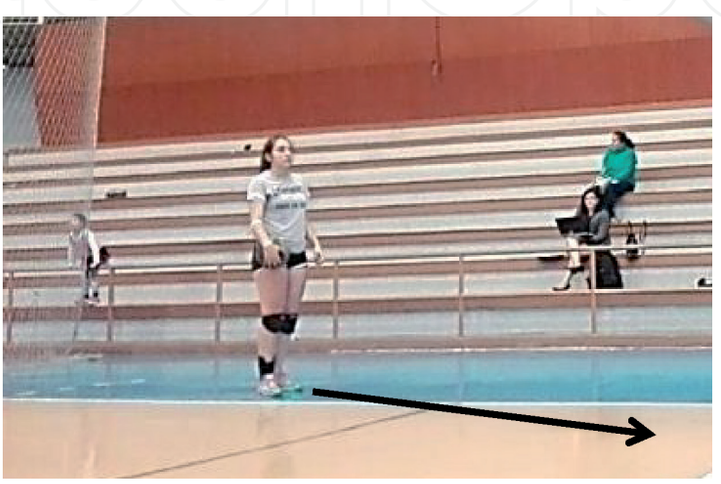

Figure 2.
Approach race.

In boosting whipped extension joints of the concentric and eccentric generate trunk contractions powertrain causing the decline of the center of gravity and then release energy and raise the center of gravity in addition to the accompany him to the swing arm both the boost phase and prior to increases braking 54% vertical speed during the jump should be noted that the jump support is more common in women with a 16% incidence in the game although according to several authors twice support generates more height but requires more time [13]. "The angle of the (right) foot forward corresponds on average to 137 degrees while the left leg angle of 162 degrees. That is, while the member that one time one-two is placed in a moderate bending, two time member is placed in greater flexion" [15] (**Figure 3**).

Preparation for beating is the phase in which the feet lose contact with the ground and the shoulder hitting the ball reaches its maximum height [16]. In this phase, the players are airborne and must perform movements that allow generation of the maximum speed of the ball striking the hand, where three phases are involved: preparation, assembly, and acceleration. During preparation, the feet leave the ground and shoulder internal rotation occurs; in the stage of assembly of the shoulder, external rotation starts and ends at the start of the internal rotation as the arm strikes; finally the acceleration is the phase in which the internal rotation of the shoulder ends with the contact of the ball, which will have the speed with which it was impacted and this is around 69.2 km/h—it should be emphasized that this is not the maximum speed of the auction but the speed with which the ball arrives at impact [17] the hand does not hit the ball follows the trajectory of the arm forward and up, at the same time the elbow of the arm that performs the beating describes the same path hand accompanied by the elevation of the head and bending the movements legs causing a bow. As for the speed with which the hand hits the ball, it depends 46% extension in 20.5% of the rotation of the shoulder, 14.5% of the performance of the trunk rotation, by 7, 5% forward displacement of the center of gravity during the jump, 5.5% of wrist flexion and 6% remaining dependent on other factors [8] (**Figure 4**).

Figure 3.
Beat.

Figure 4.
Preparation for the hitting.

Phase of scrimmage begins at the moment when the hand that takes the blow comes into contact with the ball and ends when losing contact with it; usually an angle of 140–170° is formed in the shoulder. A the ends movements acceleration phase product elbow extension which ends the movement of the arm describes the path following occurs: forward and downward, further movement compensation of the where the most important undercarriage are performed: extension knee and rotation of the trunk [8]. In this phase, the shoulder should reach the maximum height until the hand contacting with the ball is at its highest point [16]; the steps involved in the kinetic chain are: hip rotation around the vertical axis, displacement and rotation of the trunk, flexion and rotation of the shoulder, elbow extension and pronation of the forearm and wrist flexion [18].

From the point of view of biomechanics, the remante to the reach the stage meets scrimmage with two goals: the first is to reach the maximum height, which is a function of the anatomical and physical capabilities of each player. The second is to reach full speed and this will depend on the position of the hand when it hits the ball. So, having separate fingers (cup position) ensures a path with maximum speed and right direction; also, the body must be fully extended and perpendicular to the floor being located slightly ahead of the shoulder arm hit factors dependent approach stroke and the place where the clay is performed (jump) [14]. Muscles that most influence the movement are: trapezius, deltoid, pectoral, subscapular, prickly infra, supraspinatus, biceps, triceps, flycatchers, abdominal, and teres major quadriceps (**Figure 5**).

The phase of the drop starts when the hand hits the ball descend in front of the body and due to gravity the player descends into contact with the ground, which takes a cushioning movement through knee flexion [19]. The support for body is through both legs (damping) involving joint ankle, knee, and hip in the order of the parts of the body in contact with the ground to end the balance fall through pendulous movements made by the opposite arm, which carries the blow [18]. The purpose of this phase is to reduce the stress of the repetitive impact of the body against

Figure 5.
Hit.

the ground to protect the joints of the ankle, knee, hip, and spine from injury. Also, the fall must be performed with two supports (2 ft) to divide the force of the impact (9.8 m/s by body weight); the muscles involved in the movement are: soleus, twins, hamstrings, erector spinae, rectus abdominis, dorsal, deltoids, biceps, and triceps [8] (**Figure 6**).

Biomechanics is the study of the application of laws and mechanical foundations of biology, especially structures of the musculoskeletal system and muscle activity; it also examines the internal and external forces acting on the human body and the effects they produce [20]. To make qualitative or quantitative analysis, one should consider three aspects: movement control, the structure of the body moving, and strength are already external and internal [21]. Finally biomechanics can establish the principles of training patterns of movement, to achieve the optimal technique taking as a starting point variability bilógicos systems (changes in athletes as the age maturation of the neuronal system, bone growth, evolution physical capabilities) and thus establish ranges that determine the level and stability domain of a technical model [22]. Furthermore, kinematics is the spatially detailed study of the movement of bodies, based on the displacements, whose velocities, accelerations, and forces cause the movements that are present in said displacements [23]. The locomotor allows kinematic analysis of the body through capturing movement then deducing equations. In addition, the musculoskeletal system is analyzed and as delivery this force to accelerate and decelerate the limbs to generate movement [24]. The biocinemática chain is successively joining a number of pairs biocinemáticos, whether open or closed [25]. From the point of view of engineering, it is a closed system in which every movement has a relationship; therefore, it ensures that all forces are transmitted positively and by default. Meanwhile, in a living organism, it is an open system where its dimension is determined by the linear distance from a hinge axis to another; it comprises muscle mass, bone structure, and the type of joint [26]. A biokinetic pair involves two bone members moving together where the chances of the movement depend on the structure of the union and the influence of muscles [25], while an open kinetic chain comprises of movements where the distal segment (hands or feet) moves freely in space with the body staying at a fixed point [27].

Figure 6.
Fall.

While the angle of movement is a way of providing a position; while the angle change is a distance covered by an angular movement from the point of view of Fisca activity is considered to angular movements made by a segment of the body relative to the hinge that is performed [28]. Finally, the center of gravity of a rigid body is the point of equilibrium, so that all the forces acting on the body are balanced, that is, their sum is equal to 0. For a flexible body, the body's center of gravity changes depending on the form of the body. For a person who is standing, it is located right at the level of the second sacral vertebra on a vertical line that touches the ground about 3 centimeters ahead of the ankle joint. It is all-important to possess the ability to vary the position of the center of gravity to maintain balance while walking or athletic actions are executed [29].

Participants in the study carried the art capping front biomechanically analyzing the different phases of the technical gesture (**Tables 1**–**4**) using the angle of the elbow to the preparation phase of the beating and phase hit to the ball, also of the angle of the column for the remaining phases of the technical movement. The software Kinovea 8.15 (experimental release) was used for biomechanical measurements. Data collection was performed at the Coliseum volleyball Concentration Deportiva de Pichincha under situations reestablished with periods of complete rest (6 min between kick) and a total of three shots for each player. Data collection involved athletes performing three shots on the opposite field region 4, of which the best shot for the respective biomechanical analysis was chosen, using a Sony professional, pointing out landmarks of interest. The videos were recorded in 2 days: on the first day, videos of 11 athletes of the prejuvenile team were recorded and on the second day, those of 8 athletes from the youth team were recorded.

The comparison of the technical stages of the closing or attack volleyball were performed using SPSS v.22, using the Mann-Whitney U test ($p \leq 0.05$) for two independent samples to the absence of normal distribution of the data [30].

2. Methods

Probabilistic not intentional sampling was used, where we studied the population of athletes from the volleyball team of the Sports Concentration of Pichincha,

No.	Edad (años)	Medida (cm)	1st phase angulo columna	2nd phase angulo columna	3rd phase angulo codo	4th phase angulo codo	5th phase angulo columna	TTR	TPG	ACCG
1	16	28	161.50	154.90	33.00	215.00	176.20	2.05	0.20	170.8
2	15	25	156.40	151.80	80.00	249.00	172.80	1.95	0.17	178.3
3	16	27	165.30	162.00	85.00	215.00	171.60	1.85	0.27	172.4
4	16	26	151.90	162.60	335.00	209.00	141.20	1.98	0.13	178.4
5	15	24	144.90	157.80	90.00	211.00	176.80	1.74	0.13	173.3
6	15	25	162.50	168.20	68.00	185.00	171.10	1.71	0.20	178.9
7	16	26	140.20	160.60	45.00	207.00	159.80	2.28	0.24	175.6
8	15	26	154.50	172.20	68.00	192.00	165.00	2.25	0.20	170.3
9	16	26	143.80	175.30	75.00	218.00	179.80	1.95	0.20	163.2
10	15	25	148.50	169.30	73.00	220.00	173.40	1.85	0.24	177.2
11	16	24	161.00	176.30	29.00	221.00	163.40	1.78	0.24	169.8
Promedio			153.68	164.64	89.18	212.91	168.28	1.94	0.20	173.47

TTR: Tiempo Total del Remate; TPG: Tiempo de la Preparación hasta el Golpe; ACCG: Ángulo del cuerpo en relación al centro de gravedad.

Table 1.
Variables en deportistas prejuveniles.

No.	Edad (años)	Medida (cm)	1ra fase angulo columna	2da fase angulo columna	3ra fase angulo codo	4ta fase angulo codo	5ta fase angulo columna	TTR	TPG	ACCG
1	23	25	152.10	174.80	83.00	164.00	171.80	2.01	0.24	175.4
2	25	23	154.80	168.00	91.00	191.00	154.20	1.68	0.20	177.8
3	17	24	160.20	162.80	69.00	179.00	156.30	1.28	0.17	173.6
4	17	23	151.60	178.50	95.00	157.00	142.40	1.85	0.24	169.8
5	18	25	159.60	166.30	110.00	200.00	174.30	1.58	0.24	175.8
6	17	27	158.40	161.10	65.00	188.00	149.40	1.44	0.17	177.4
7	20	28	163.10	166.60	93.00	190.00	144.10	1.95	0.24	169.5
8	22	25	160.50	173.20	89.00	197.00	169.40	1.41	0.20	179.4
Promedio	157.54	168.91	86.88	183.25	157.74	1.65	0.21	174.84		

TTR: Tiempo Total del Remate; TPG: Tiempo de la Preparación hasta el Golpe; ACCG: Ángulo del cuerpo en relación al centro de gravedad.

Table 2.
Variables en las deportistas juveniles.

	Group	N	Average range	Sum of ranks
Angle column	Pre youth	11	13.36	147.00
	Youth	8	5.38	43.00
	Total	19		
Contrast statistics[a]	**Angle elbow**			
U de Mann-Whitney	7000			
W de Wilcoxon	43,000			
Z	−3057			
Sig. asintót. (bilateral)	.002			
Sig. exacta [2 × (Sig. unilateral)]	.001[b]			

[a]*Group variable: Group.*
[b]*Not corrected for ties.*

Table 3.
Elbow angle in the striking phase.

	Group	N	Average range	Sum of ranks
Auction time	Pre youth	11	12.36	136.00
	Youth	8	6.75	54.00
	Total	19		
Contrast statistics[a]	**Auction time**			
U de Mann-Whitney	18,000			
W de Wilcoxon	54,000			
Z	−2154			
Sig. asintót. (bilateral)	.031			
Sig. exacta [2 × (Sig. unilateral)]	.033[b]			

[a]*Group variable: Group.*
[b]*Not corrected for ties.*

Table 4.
Time it takes to complete the technical basis of the auction.

with 11 athletes from the prejuvenile team (16–17 years) and 8 athletes from the youth team (18–19 years), all females.

3. Results

Table 1 shows the data obtained from the 11 prejuvenile athletes where average 153.68° was obtained in the first phase; an average of 164.64° was obtained in the second phase; 89.18° in the third stage; an average of 212.91° in the fourth stage; and an average of 168.28° in the fifth phase. In the total execution time of the auction technique (TTR) averaged 1.94 s, while the preparation time until the stroke of the ball (TPG) was averaged from 0.20 s, yielding an average of 173.47° in the angle of the body in relation to the center of gravity at the time of impact with the ball.

Table 2 shows the data obtained from 8 juvenile athletes studied. We obtained an average of 157.54° in the first phase; 168.91° in the second phase; 86.88° in the third stage; 183.25° in the fourth stage; and an average of 157.74° in the fifth phase of the technical movement studied. In the total execution time of the auction technique (TTR) averaged 1.65 s, while the preparation time until the stroke of the ball (TPG) was averaged from 0.21 s, yielding an average of 174.84° in the angle of the body in relation to the center of gravity at the time of impact with the ball. **Tables 3** and **4** the results of statistical contrast values also shown that generated significant differences Mann-Whitney U ($p \leq 0.05$) samples.

Table 3 shows that the average range of the preyouth team is 13.36 and the average range of the youth team is 5.38; after analyzing in the SPSS program, it is observed that there is a significant difference since the value obtained is 0.002, which is less than 0.05.

Table 4 shows that the average range of the preyouth team is 12.36 and the average range of the youth team is 6.75. After analyzing in the SPSS program, it is observed that there is a significant difference since the value obtained is 0.031, which is less than 0.05.

4. Discussion

In the phase of stroke approximation n lower average range is evident in the áng ulo column group pre juvenile (9.18) obtained in the young group (11, 13) with no significant differences ($p = 0.492$). In the whisk the angle of the column in relation to the floor was evidenced with a lower average range in the preyouth group (8.82) than that obtained in the youth group (11.63), without significant differences being evidenced ($p = 0.310$), while the preparation phase for the beating of the same form showed a lower average range in preyouth (8.09) than in youth (12.63), there being no significant differences between the independent groups studied ($p = 0.091$).

On the other hand, in the beating phase the preyouth group obtained a higher average range (13.36) than that obtained by the youth group (5.38), there being significant differences ($p = 0.001$) according to the Mann-Whitney statistics; to conclude, in the fall phase there are no significant differences ($p = 0.091$), although the average range of the angle of the spine is greater in the prejuvenile group (11.91) than in the juvenile group (7.38).

When comparing the rest of the variables studied, significant differences were evidenced in the total time of the auction (TTR: $p = 0.033$), the average range being higher in the preyouth group (12.36) than that obtained by the youth group (6.75), while there were no significant differences when comparing the time of preparation to the strike (TPG: $p = 0.717$) and the angle of the body in relation to the center of gravity (ACCG: $p = 0.717$) between independent groups—in both cases there is a lower average range in the preyouth group (TPG = 9.55 and ACCG = 9.59) than in the youth group (TPG = 10.63 and ACCG = 10.56). According to the latest research on biomechanics applied to the auction, we can find that the results allow us to demonstrate what has been exposed by [9] since in his research he concludes that analyzing the technical element allows to know the movement parameters by establishing more specific parameters on the movement patterns present during the execution of the movement. Finally, the values that determine that there are significant differences (beating) correspond to what was stated by Castro et al. [2] since according to his research when comparing the effectiveness of the auction in two different subjects exist differences either by their anthropometric characters physical condition or by the teaching process learning technique.

5. Conclusion

In the angles of the column it was observed that there were no significant differences in the technique of the auction; nevertheless, in the angles of the elbow influence was observed for a better flexion of elbow and placement of the hand, being able to generate a greater impact to the ball and therefore greater difficulties to the opposing defense. It is concluded that since there are significant differences in the striking phase, it is possible to verify the exposition of the studies on biomechanics where the influence of training time, that is, experience, allows movements to be more efficient and generate better results, whether dynamic or kinematic. Say when comparing preyouth players with youth, age, motor development and experience in youth players generate differences, however it should be noted that it is a minimum value which means that during practice and according to the analysis errors can be corrected technicians and in this way obtain a higher level of effectiveness while training the movement patterns that must undergo improvements.

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